INDUSTRIAL WASTE SAMPLING PROCEDURES MANUAL

JANUARY 1989

Environment Ontario

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Minister

ISBN 0-7729-4893-3

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January 1989

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I INTRODUCTION

Ontario's Waste Management Regulation (Regulation 309) includes specific liquid industrial and hazardous waste definitions. Wastes are now classified by means of a listing/testing approach similar to that developed by the United States Environmental Protection Agency. In this approach possible hazardous waste characteristics are determined by specified laboratory tests and criteria. For characteristics such as toxicity however, where tests or criteria are not firmly established, wastes of concern are listed.

Waste generators need to evaluate their wastes to determine if they are subject to registration, manifest and other regulatory requirements. Waste evaluations based on reliable data are also needed for waste handling, treatment, disposal and enforcement purposes.

Since it is not normally practical or desirable to test entire waste streams, meaningful analytical results are dependent on obtaining waste samples that represent the bulk waste material from which they are taken. Unfortunately, industrial waste streams are frequently complex mixtures of liquids, sludges and solids that do not readily lend themselves to simple sampling techniques. They can have wide ranges in properties such as viscosity, and can be found in a variety of containers including drums, tanker trucks, storage tanks, bins, lagoons or ponds. To accommodate the diversity of waste streams and potential sampling situations, a variety of sampling devices are needed.

The purpose of this manual is to provide assistance with regard to sampler selection and procedures for obtaining representative waste samples. Both general and specific sampling considerations are discussed. A sampler selection chart is provided to assist with the selection of an appropriate sampler and to provide a summary of pertinent sampling details including safety considerations.

While attempting to provide direction for most of the sampling situations that may be encountered, this manual does not address all possible liquid industrial and hazardous waste sampling scenarios. Depending on the specific sampling requirements, one will need to supplement the information contained in this manual with professional judgement and common sense. As an alternative, the services of a consulting or analytical testing service may be retained to assist with sampling needs.

This manual should be used in conjunction with the Ministry publication entitled - A Guide to the Collection and Submission of Samples for Laboratory Analysis (1).

II GENERAL CONSIDERATIONS

Considerable time, effort and cost can be associated with sampling and testing industrial waste streams. Therefore, care must be taken from the start to ensure sample integrity. Generally, the following four considerations will help ensure that data obtained from the sample are meaningful.

1. Prior to sampling, obtain background information about the waste stream to be sampled and establish safety requirements. Information sources include the generator, carrier or receiver as well as numerous hazardous material reference texts (2, 3, 4, 5). If there is uncertainty as to what safety procedures should be taken, consult with a safety officer or supervisor.

2. Develop a sampling strategy. It should include the location, number and size of samples required based on the analytical tests to be performed as well as the selection of a suitable sampler, sampling method, sampling point and sample containers. For additional details consult (1).

3. Clearly label sample containers and identify any possible hazardous materials. Close the containers securely to avoid contamination or leakage. Record sampling details in an appropriate sampling log book. Consult the Transportation of Dangerous Goods Regulations (6) for details relating to shipping and packaging requirements for test samples that are dangerous goods.

4. Maintain sample integrity by using proper preservation and storage techniques and by ensuring prompt transportation to reliable testing agencies. The protocol for obtaining legal samples is described in "A Guide To The Collection And Submission Of Samples For Laboratory Analysis"(1).

It is important to ensure that all of the necessary equipment needed for sampling, including safety equipment, is organized beforehand. Sampling equipment must be clean and in good operating condition. If samples are to be taken for legal or regulatory purposes, use new (unused) samplers and bottles or ones that have been cleaned thoroughly using recognized laboratory cleaning techniques (see Sampler Cleaning Section for details). Samplers being transported to a sampling site should be stored in proper containers. Care must be taken to avoid any possible contamination of the samplers prior to use.

When selecting sample containers and equipment, ensure the material of construction (glass, plastic, etc.) is compatible with the waste stream being sampled (7). The containers should be resistant to chemical attack by the waste being sampled and should be capable of holding the volume required for subsequent testing purposes.

Glass containers are resistant to attack by most industrial wastes excluding wastes that contain hydrofluoric acid and some very strong alkalis. Plastic containers, while being less breakable, are normally not as resistant to chemical attack. The best choices for plastic containers are those made of linear polyethylene or teflon FEP (fluorinated ethylene propylene).

If in doubt about the size and type of sample container to use, consult the testing laboratory that will be performing the analysis for direction. Consideration may also be given to retaining the services of the laboratory performing the analytical tests or another suitable professional service to perform the sampling.

In certain situations, such as sampling for enforcement purposes, it will be necessary to take three replicate samples. One of the samples must be retained by the sampling agency while the other two are submitted for analysis. The retained sample can be used if problems arise with either of the originally submitted samples. For additional legal sampling details, please refer to "A Guide To The Collection And Submission of Samples For Laboratory Analysis"(1).

III SAMPLING

Safety Considerations

It is essential to take safety precautions when sampling liquid industrial and hazardous wastes. Sampling personnel and their employers must comply with the requirements of Ontario's Occupational Health and Safety Act and Regulations for Industrial Establishments (8). For extreme conditions an optimal level of protection for sampling personnel can be provided by full protection suits with supplied air respirators used in conjunction with suitable air monitoring equipment.

While the use of full protection equipment may be warranted in some hazardous or suspected hazardous sampling situations, it is probably not required for most liquid industrial or hazardous waste that may be encountered. Background information on a waste stream obtained from the generator, carrier, receiver or hazardous waste/materials reference texts can be used to determine specific safety requirements. For many sampling situations the standard safety equipment outlined below should be adequate.

1. Protective clothing includes long sleeve coveralls, an oil/acid proof apron, rubber coat and pants or other similar protection coverings.

2. Gloves that are chemically resistant to the materials being sampled. While neoprene gloves are resistant to most chemicals, it is best to refer to a safety equipment catalogue to determine which type of glove is most suitable.

3. Chemically-resistant boots made from rubber or neoprene. Vinyl plastic overboots may also be suitable. Refer to a safety equipment company for additional guidance.

4. Safety goggles, masks or face shields. A large variety of these are commercially available from safety equipment or laboratory supply outlets.

For sampling situations in which one anticipates the presence of toxic gases, vapour, mists or dusts, there is a need to select appropriate respiratory protection devices. These devices include face masks with suitable canisters, cartridges, filters, as well as complete self-contained breathing apparatus. Selection charts identifying hazardous gases and correspondingly suitable filters and canisters can be found in safety supply or laboratory supply catalogues. However, improper use of these devices in a hazardous

environment could result in injury or death. Therefore, respiratory protective devices should be used only by trained personnel. In circumstances for which respiratory devices are determined to be necessary, consult with a safety officer or supervisor to ensure proper usage. Consult "Samplers and Sampling Procedures for Hazardous Waste Streams" (7) for additional information relating to respiratory protective devices.

It is good practice for two people to sample potentially hazardous materials or in potentially hazardous locations. Depending on the degree of hazard anticipated, the second person, stationed at a safe distance from the hazard, can be in contact with the first by two-way radio if necessary and provide assistance or call for help as required. If in doubt whether two people are required, consult with a safety officer or supervisor and follow their recommendations.

Sampling in a confined space requires special precautions. Before sampling, one should verify with a safety officer or supervisor, the procedures for confined space entry.

In cases where there are serious threats from fires, explosions or possible toxic gas reactions, additional special precautions may be required. These types of problems have been addressed by the U.S. Environmental Protection Agency (7). Options discussed include the use of remote bung openers or drum piercers.

Representative Sampling

The waste to be sampled may be homogeneous or heterogeneous. The selection of a sampling strategy depends on what type of variability the waste exhibits. The sampling program should give results which are statistically valid and reproduceable.

Time Variability

Time variability is most often encountered when point discharges are sampled, such as flow from pipes. A time composite sampling technique is usually applied in these cases. Using this method, a number of grab samples of equal volume are taken at regular times from the discharge pipe. The time at which the samples are taken depends on the process, its operating schedule, and the schedule of variation of the waste composition. The greater the variability, the more grab samples must make up the composite sample. The volume of waste required must also be determined beforehand; it is usually dictated by the methods of analysis and the homogeneity of the waste material.

- For example, a one-litre daily composite could consist of five 200-ml samples taken at two-hour intervals throughout the day; a weekly composite could consist of seven samples taken on seven consecutive days and then combined. The schedule for a composite is process-dependent and should be decided upon by someone who is familiar with the process.

Note: When sampling point discharges, it is also possible that the flow will vary and therefore time composite samples may be inappropriate. The sampling procedure used to compensate for this situation, flow proportional sampling, is quite elaborate and may require the establishment of a "permanent" sampling station and the use of more sophisticated sampling equipment. If the flow is variable, consult with the laboratory or a consultant to obtain the necessary equipment.

Spatial Variability

Waste variability within a container, pile, landfill, or lagoon may be vertical and/or horizontal. Contained wastes have a much greater tendency to vary in a vertical rather than a horizontal direction because of the settling of solids, differences in the relative densities of materials in the waste and variations in the composition of the waste as it enters the container.

It is necessary to characterize the waste's variability in both the horizontal and vertical dimensions. This usually means collecting a complete vertical sample of the waste at several randomly selected points on a horizontal grid. The number of samples to be taken will vary with the size of the containment area and the degree of spatial variability. An appropriate number of samples to allow the determination of statistical reliability should be taken. Plotting results on "Probability Paper" is an easy way to determine the reliability.

Sampler Selection

As previously indicated, sampling the wide range of liquid industrial and hazardous wastes requires a variety of different samplers and sampling techniques. The ultimate selection of an appropriate sampler depends largely on the type of waste being sampled and the type of container in which it is found.

While it is impossible to predict all of the waste type and container situations that may be encountered, Table 1 outlines several different waste type/container scenarios and suggests which sampler to use. It also identifies appropriate sampling points, the number of sampling increments to be

taken, safety considerations as well as other pertinent details. It is recommended that Table 1 be consulted prior to initiating any industrial waste sampling.

If the review of Table 1 identifies a profile (tubular) sampler as the suggested sampler, consult with Table 2 of this guideline to determine which profile sampler is best suited to that specific sampling situation.

If a sampling scenario does not fit any of those identified in Table 1, select a sampler and sampling procedure that will obtain a representative sample while maximizing personnel safety.

Once an appropriate sampler has been selected, a sampling summary or checklist that addresses the following points should be prepared:

1. Safety equipment required and possible safety precautions;

   - list the type of equipment required such as coveralls, acid/oil resistant apron, rubber gloves, boots and safety mask.

   - list any safety precautions that may be warranted such as avoiding inhalation of ambient air or avoiding the creation of sparks.

2. Sampling equipment required;

   - list the number and type of samples and sample containers required including 1 or 2 extras. The number and type of containers selected will depend on the analyses to be performed and the waste being sampled. Additional equipment requirements could include devices to open waste containers such as a bung wrench for drummed waste.

3. Sampling locations;

   - identify appropriate sampling location(s). Samples can be taken from in-line processes, waste storage tanks, waste collection vehicles, drums, etc. You should also determine an exact sampling point(s).

The actual sampling of the waste stream should be carried out in accordance with the procedures described in **Appendix I and Appendix II** for the sampler you have selected.

Sample Size Reduction

If a collected sample is too large to submit to a testing agency it may be necessary to split the sample into smaller representative portions.

Solid Samples

For solid samples, such as soils, sample splitting can be accomplished by applying either of the following two sample splitting techniques.

1. Coning and Quartering

   Mix the sample thoroughly with a shovel or scoop and pile it into a cone. Each shovelful should be placed at the apex of the cone and allowed to run down the sides. After repeating this several times, flatten the cone into a rough circle of uniform thickness and divide into four quarters. Reject two opposite quarters and retain the others. If required the rejected quarters may be stored as back-up or reference samples until testing is completed. The procedure of coning and quartering, and then rejecting opposite quarters, can be repeated until the approximate required sample size is obtained.

2. Riffling

   As an alternative to the coning and quartering techniques, sample sizes can also be decreased by riffling. Riffles or sample splitters are commercially available in a variety of sizes from most laboratory supply outlets. The size of riffle required is determined by the particle size of the sample material. The generally accepted practice is to use a riffle in which the discharge openings are at least three times the size of the largest particles in the material being riffled.

   To use a riffle, start by snuggly positioning two riffle pans under the two adjacent rows of discharge openings in the riffle. Place the material to be riffled in a third riffle pan so that it is spread evenly throughout the pan. This pan is then placed over the riffle and the material is allowed to flow uniformly through the discharge slots. If the material does not flow freely. it may be necessary to shake or vibrate the riffle. After all the material has passed through the riffle, two approximately equally representative portions of sample will be contained in the two riffle pans. Further division may be carried out by rejecting one of the two portions and then repeating the above procedure on the retained portion.

   If the particle size of this sample material is too large, moist or sticky for riffling, it is recommended that the material be milled and blended prior to riffling or that the coning and quartering procedure be used.

Liquid Samples

There are no comparable sample volume reduction techniques for liquids. Liquid samples should be thoroughly mixed (homogenized) prior to any splitting or prior to removing an aliquot for testing purposes.

Sample Handling, Preservation and Storage

Once a sample has been placed in the sample container the lid should be securely tightened to avoid the potential loss of volatile components. Each sample container must be clearly labelled. The label should include the following details.

1. Type of sample and reference number

2. Date Sampled

3. Name of Person collecting Sample

4. Sampling location - (company, process, drum, etc.)

5. Hazardous warnings - including any dangerous good labels that may be required

Additional details such as waste components, tests required and suspected hazardous properties or safety considerations can be provided on the sample submission report. Check with the testing agency to obtain the specific details required.

Generally the addition of preservatives to waste samples is not recommended. However, in certain situations where components are known to degrade rapidly, refrigeration at 4 to 6°C or the addition of preservatives may be essential. See (7) for details. Regardless of preservatives or refrigeration, samples should be analyzed as soon as possible to prevent chemical characteristics from changing while in storage.

Sampler Cleaning

It is essential that sampling devices be thoroughly cleaned prior to reuse to prevent cross contamination of samples. The following procedures are recommended for cleaning samplers contaminated with aqueous wastes and organic wastes respectively.

Aqueous Waste Contaminated Samplers

1. Wash sampler in a warm detergent solution such as Alconox or Liquinox. Use brushes if required.

2. Rinse thoroughly with distilled water.

3. Air dry with a stream of forced air and wipe with laboratory tissue if required.

Organic (Oil) Waste Contaminated Samplers

1. Wipe samplers with absorbent material such as disposable tissue.

2. Rinse with suitable organic solvent such as trichloroethane or acetone.

3. Wash sampler in a warm detergent solution such as Alconox or Liquinox. Use brushes if required.

4. Rinse thoroughly with distilled water.

5. Air dry with a stream of forced air and wipe with laboratory tissue if required.

Generally, field cleaning is not recommended; however, if the samplers are being cleaned in the field, then any waste solvents used for cleaning purposes should be disposed of properly. This could involve the use of transportable solvent containers to facilitate the removal of the waste solvents from the sampling location to the laboratory.

TABLE 1 SAMPLER SELECTION CHART

TYPE OF WASTE & CONTAINER	SUGGESTED SAMPLER	SAMPLING POINT(S)	MINIMUM NUMBER OF INCREMENTS PER SAMPLE	SAFETY CONSIDERATIONS	COMMENTS
DRY SOLIDS (Powder/Granular in bags, sacks, fiber drums, barrels etc.	Grain Sampler	- for bags or sacks sample through fill openings - for drums or barrels sample through top	3	- wear standard protective clothing** - avoid inhalation of airborn particles - avoid spilling materials by rupturing bags of sacks - close containers after sampling	Procedure for use of grain sampler on page I-4
OTHER DRY SOLIDS in shallow containers including surface soils	Trowel	- divide soil surface area into an imaginary grid and remove a portion from each grid	3	- wear standard protective clothing**	Procedure for use of trowel shown on page I-1
HARD-PACKED SOLIDS in any container including soils	Auger	- divide surface area into an imaginary grid and remove a portion from each grid	3	- wear standard protective clothing**	Procedure for use of Auger shown on Page I-4 The use of a pan with a hole in it to catch auger discharge helps to avoid contamination by surface material
MOIST OR STICKY SOLIDS in any container	Sampling Trier	- refer to above sample, point details for soils, shallow containers drums, etc.	3	- wear standard protective clothing**	Procedure for use of sampling trier shown on Page I-1 Preferable to the trowel for moist sticky solids
LIQUIDS*** in drums, barrels or similar containers	Tubular Sampler	- sample through bung hole or other resealable opening	1	- wear standard protective clothing ** - bulging drums could be under pressure - release pressure prior to sampling - corroded drums may rupture - be careful not to create sparks when opening containers - reseal opening after sampling	Consult Table 2 for selection of a suitable profile sampler

TABLE 1 SAMPLER SELECTION CHART (cont'd)

TYPE OF WASTE & CONTAINER	SUGGESTED SAMPLER	SAMPLING POINT(S)	MINIMUM NUMBER OF INCREMENTS PER SAMPLE	SAFETY CONSIDERATIONS	COMMENTS
LIQUIDS*** in ponds, lagoon, pits, etc.	Pond Sampler or Weighted Bottle Sampler	- divide surface into an imaginary grid and remove a portion from each grid	3 Note: for weighted bottle sampler each grid increment should consist of 3 portions (top, middle and bottom)	- wear standard protection clothing** - two persons should be involved when sampling ponds, lagoons, or pits	Procedure for use of weighted bottle sampler and pond sampler shown on page 1-7.
LIQUIDS*** in tanker trucks or storage tanks	Profile Sampler or weighted bottle sampler	- sample through hatch or other top opening	1 for profile sampler. 3 for weighted bottle samples, (top, middle and bottom)	- wear standard protection clothing** - when sampling tanker trucks, have drivers open hatch slowly - two persons should be involved when sampling tanker trucks or storage tanks	Consult Table 2 for selection of profile sampler Procedure for use of weighed bottle sampler shown on page 1-7

* Refer to the Occupation Health and Safety Act and Regulations for Industrial Establishments

** Standard protective clothing - coveralls, rubber coats/pants, oil/acid proof apron, safety goggles/mask (See pages 6-8)

*** Liquids include sludges and slurries.

TABLE 2 PROFILE LIQUID INDUSTRIAL WASTE SAMPLERS

SAMPLER	VISCOSITY RANGE	TYPE OF LIQUID			PERFORMANCE	FIELD CLEANING
		AQUEOUS	ORGANIC	CORROSIVE		
TUBE & BALL VALVE (pg. I-11)	Low to Moderate	Suitable	Suitable	Suitable*	Good to Excellent	Not Recommended
PACS COLIWASA (pg. I-13)	Low to High	Suitable	Suitable	Suitable**	Good	Not Practical
CONCENTRIC TUBE (pg. I-13)	Moderate to High	Suitable	Suitable	Not Suitable	Good	Not Practical
CONSTRICTED GLASS TUBE (pg. I-16)	Low to Moderate	Suitable	Suitable	Suitable	Fair	Disposable
REGULAR GLASS TUBE (Pg. I-16)	Low to Moderate	Suitable	Suitable	Suitable	Poor to Fair	Disposable

* Might not be suitable for extremely corrosive liquids
** Glass construction only - Plastic not suitable
*** Performance rating based on results a study conducted for the Ministry (9)
It reflects expected accuracy and ease of use

REFERENCES

1. A Guide to the Collection and Submission of Samples for Laboratory Analysis, Fifth Edition July 1985, Ontario Ministry of the Environment.

2. Dangerous Properties of Industrial Materials, Sixth Edition, N. Irving Sax; Van Nostrand Reinhold Company.

3. Handbook of Toxic and Hazardous Chemicals, Marshall Sittig; Noyes Publications.

4. Handbook of Environmental Data on Organic Chemicals, Second Edition, Karel Verchueren; Van Nostrand Reinhold Company.

5. Emergency Response Guide for Dangerous Goods - Transport Canada.

6. Regulations Respecting the Handling, Offering for Transport and Transportation of Dangerous Goods. Transport Canada.

7. E.R. deVera, B.P. Simmons, R.D. Stephens and D.L. Storm "Samplers and Sampling Procedures for Hazardous Waste Streams". Solid and Hazardous Waste Research Division, U.S. Environmental Protection Agency (EPA 600/2-80-012).

8. Occupational Health and Safety Act and Regulations for Industrial Establishments. Ministry of Labour.

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APPENDIX I

SAMPLERS AND PROCEDURES

Solid Waste Samplers

A number of commercially available samplers are suitable for sampling solid wastes or soils contaminated with industrial wastes. The four samplers described below will likely accommodate most solid waste sampling situations that may be encountered.

1. **Trowel or Scoop**

   The Trowel illustrated in Figure 1 is easily recognized as a typical garden tool which can be purchased in hardware stores or laboratory supply outlets for calibrated trowels. It can be used to obtain shallow soils samples as well as for sampling dry or powder-like solid waste samples.

   Procedure for Use

   i) Take equal portions of sample at regular spacings from the bulk waste material.

   ii) Combine portions in a suitable container (glass bottle, plastic bottle or plastic bag) until desired quantity is obtained.

2. **Sampling Trier**

   The sampling trier shown in Figure 2, consists of a long tube which has a slot that extends over most of its length. It is normally made from stainless steel and has a wooden handle and can be purchased from laboratory supply outlets. The sampling trier is suitable for sampling sticky powder or granular materials as well as loosened soils.

   Procedure for Use

   i) Insert trier into the material being sampled at an angle between 0 and 45° from horizontal and rotate to core the sample, if necessary.

   ii) With slot facing upward, withdraw the sample and place in a suitable container.

   iii) Remove additional portions in a similar manner until the desired quantity is obtained.

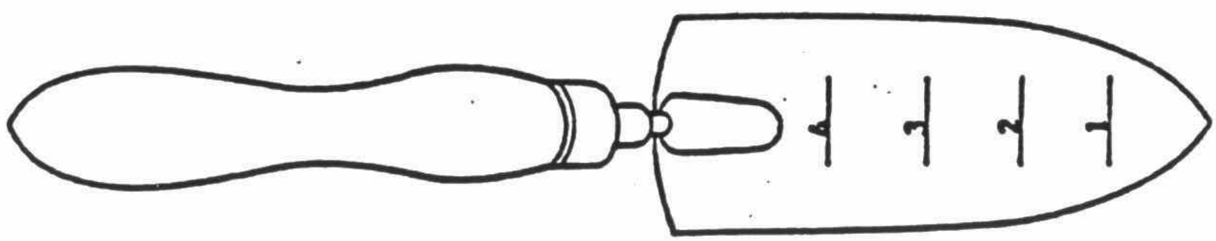

Figure 1 - Calibrated Trowel

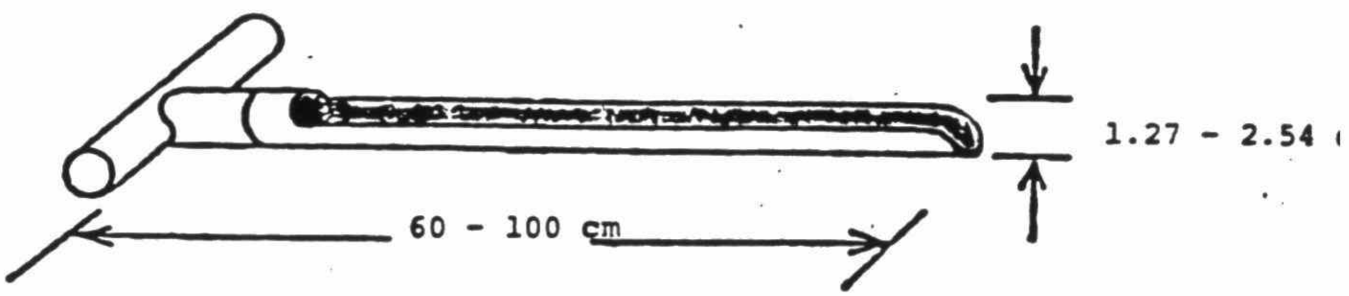

Figure 2 - Sampling Trier

3. **Grain Sampler**

The grain sampler shown in Figure 3, is made up of two slotted tubes that are opened and closed by rotating the inner tube. The outer tube is pointed to allow the sampler to penetrate the material being sampled. A grain sampler can be used to sample powdered or granular materials from containers such as bags or drums and may be purchased from laboratory supply outlets.

Procedure for Use

i) Insert closed sampler into material being sampled.

ii) Rotate inner tube to open sampler and wiggle to allow material to flow in.

iii) Rotate inner tube to close sampler and withdraw.

iv) Place sampler in horizontal position, slots facing upward, then rotate and slide the outer tube away from the inner tube.

v) Place inner tube sample material into a suitable container.

vi) Repeat this procedure until the desired sample volume is obtained.

4. **Soil Auger**

The soil auger illustrated in Figure 4 is a manufactured tool consisting of sharpened spiral blades. Soil augers come in a variety of sizes and can normally be purchased from farming supply outlets, or related suppliers. As implied by the name, these samplers are suitable for sampling soil.

Procedure for Use

i) Cut a circular hole in an aluminum pie pan (or something equivalent), large enough to allow the blades of the auger to pass through.

ii) Position the pie pan over the selected sampling point and auger through the hole until to the desired depth.

iii) Remove the auger slowly and catch the soil sample in the pie pan and then transfer this material to a suitable sample container. Remove any loose soil from sample hole and transfer to the sample container.

iv) Repeat the above procedure until the desired sample quantity is obtained.

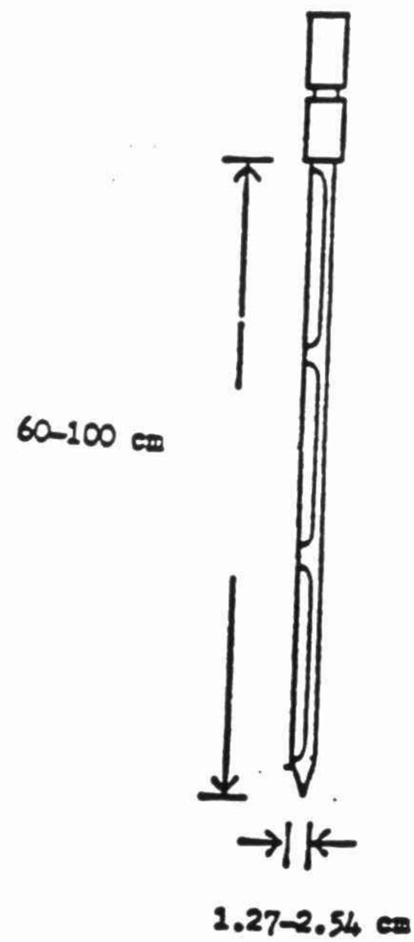

Figure 3 - Grain Sampler

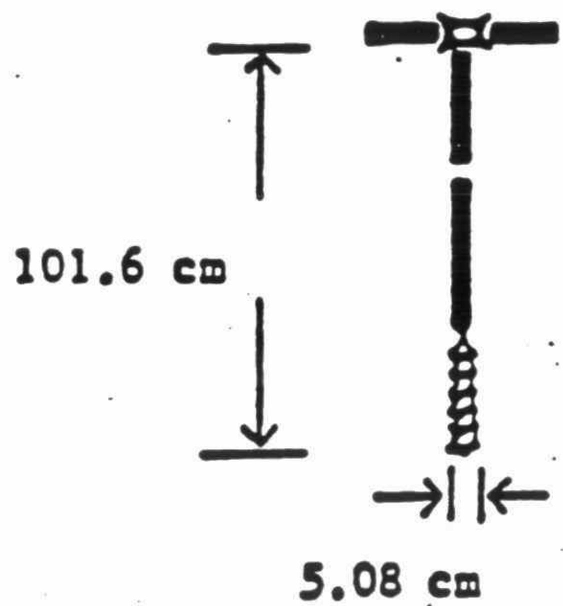

Figure 4 - Soil Auger

Liquid Waste Samplers

It is anticipated that the majority of wastes sampled, with respect to the requirements of Regulation 309, will be liquids. Unfortunately, liquid wastes can also be the most difficult to sample. To date, there is no general agreement relating to the best methods for obtaining representative liquid waste samples, particularly when the waste stream consists of multiphased heterogeneous mixtures.

A number of different liquid waste samplers are available commercially or can be constructed from readily available materials. Essentially, these samplers can be broken down into two categories; grab liquid waste samplers and tubular (profile or core) liquid waste samplers. Grab liquid waste samples must be composited in order to be representative. Profile waste samplers on the other hand are designed to give individual representative samples.

Grab Liquid Waste Samplers

1. **Dipper (Pond) Sampler**

   The dipper sampler shown in Figure 5, consists of a beaker secured to an aluminum telescoping pole by means of an adjustable clamp. This sampler is suitable for sampling surface levels of lagoons, ponds or tanks. While it may not be commercially available, the dipper can be constructed from readily available materials. Beakers and clamps may be purchased from laboratory supply outlets, while telescoping tubes may be purchased from hardware stores or swimming pool supply outlets.

   Procedure for Use

   i) Assemble sampler and secure beaker with clamp.

   ii) Take grab samples at various locations in the sample medium (pond, lagoon or tank) and place these in a suitable sample container until the desired volume is obtained.

2. **Weighted Bottle Sampler**

   The weighted bottle sampler shown in Figure 6, consists of a stoppered glass bottle which is contained in a weighted sinker. It is equipped with a line that is used to lower or raise the sampler as well as to open the bottle. This sampler can be used to obtain grab samples from the bottom of wells, storage tanks, ponds or lagoons. It may also be used to obtain grab samples at various depths which can then be composited to provide an estimate of the waste profile. For example, one sample can be taken near the top, another near the middle and one near the bottom.

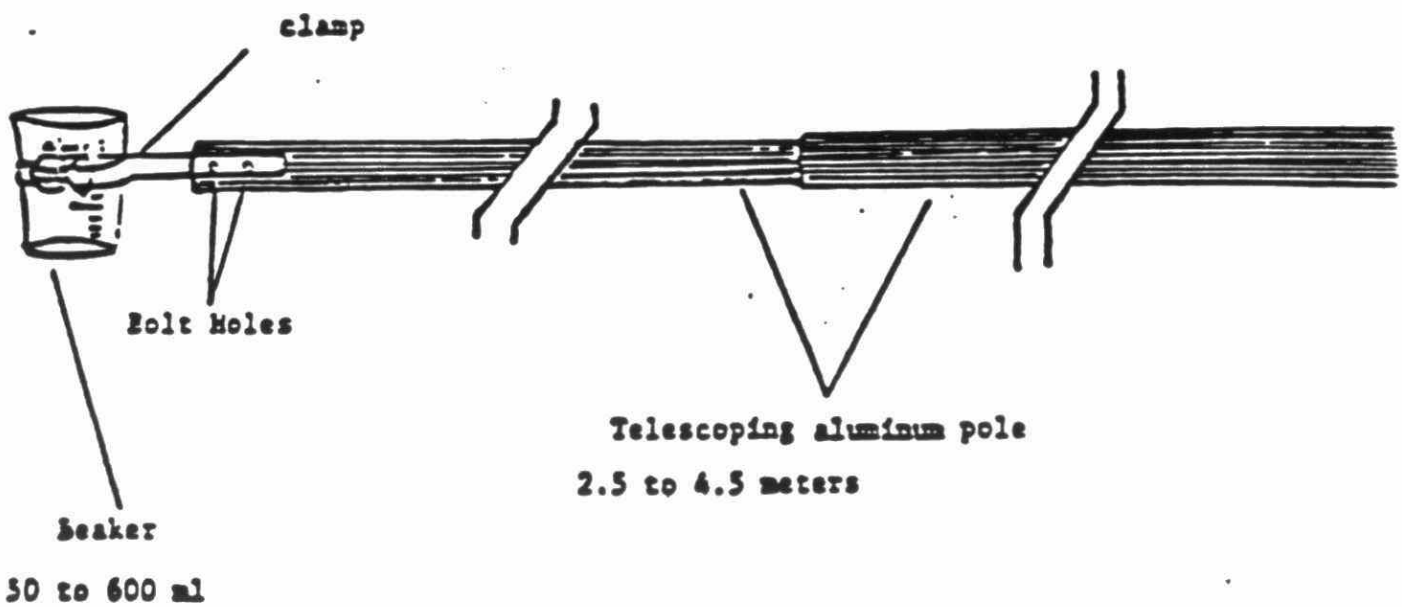

Figure 5 - Dipper Sampler

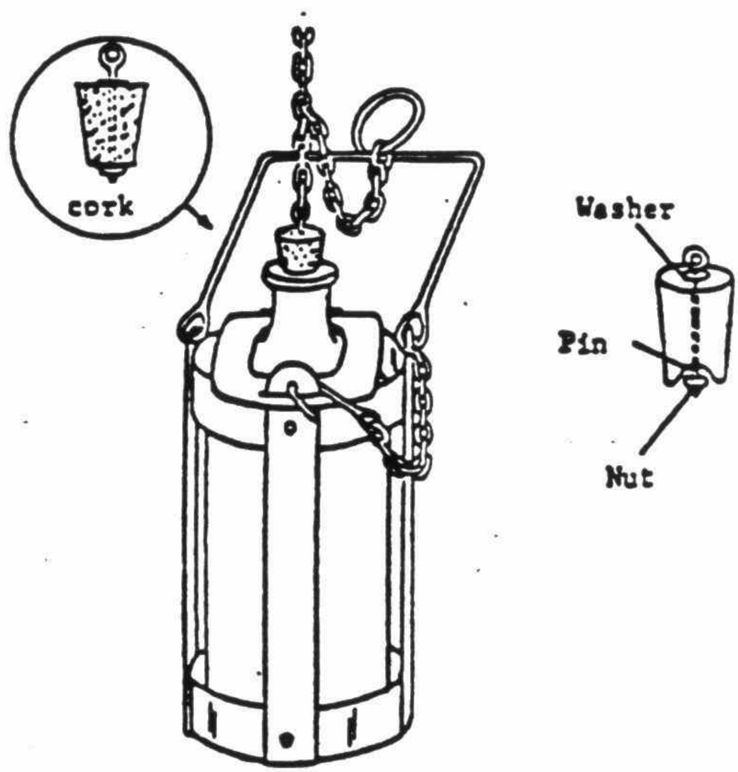

Figure 6 - Weighted Bottle Sampler

Procedure for Use

i) Insert the stoppered sampler into the liquid to be sampled at the desired depth by means of the sampler line.

ii) When the sampler is at the desired depth, pull out bottle stopper with a sharp jerk of the sampler line.

iii) When the bubbling stops, raise bottle.

iv) Wipe bottle sampler with clean rag, then deposit sample into sample container.

v) If more than one sample is being taken (e.g. more than one depth), use a clean bottle for each sample.

vi) Repeat the above procedure until desired sample quantity is obtained.

Tubular (Profile or Core) Samplers

A number of tubular samplers are either commercially available or can be fabricated relatively easily from commercially available materials. Essentially, tubular samplers are used to obtain samples that provide a representative profile of the material being sampled. This is especially important when the liquid waste being sampled consists of more than one phase and when the hazardous constituents are not vertically consistent. For example, contaminant concentrations may be higher near the bottom of a drum than near the top of a drum.

Many tubular samplers have been tested over recent years, however, to date, there is no universal agreement as to which is the best. The accuracy, and hence, credibility of samples obtained by tubular samplers is dependent on sampler design and sampling technique. No tubular sampler is clearly superior in all aspects. All have advantages and disadvantages and frequently accuracy is the trade-off for convenience.

Based on the results of a recent sampler study which was conducted for the Ministry of the Environment, a number of tubular samplers are recommended for use in various liquid waste sampling situations. One sampler, in particular, demonstrated significant and consistent advantages. This sampler, which utilizes a tube and ball valve mechanism at the end of a copper tube, appears to provide a good combination of convenience and accuracy.

1. Tube and Ball Valve Sampler

The tube and ball valve sampler described in Figure 7, consists of a length of 14 mm I.D. copper tube having a ball valve attached at the lower end. An optional extender can be added to permit sampling deeper containers. The valve mechanism is activated (closed) by pulling a wire which runs through guides along the outside of the copper tube. This sampler is not commercially available, but can easily be manufactured from materials which are available at any hardware store.

The tube and ball valve sampler is suitable for sampling most containerized liquid wastes with the possible exclusion of liquids that are highly corrosive or extremely viscous. An alternative to the copper construction, such as stainless steel, would make the sampler more suitable for sampling highly corrosive wastes.

Procedure for Use

i) Open valve mechanism by hand and visually inspect to ensure valve is open.

ii) While holding the sampler vertically, lower it into the liquid being sampled at a slow constant rate. For liquids with viscosities similar to water, lower at a rate of about 30 cm per 5 seconds. For more viscous liquids, lower at proportionally slower rates. Note: lowering this sampler too quickly will bias the sample obtained.

iii) When the sampler touches the bottom of the sample container raise very slightly (no more than $^1/_2$ cm), wait 3 seconds and close valve by means of the pull wire.

iv) Raise sampler vertically and remove from sampling liquid. Wipe the outside of sampler with suitable rag. Position sampler above sample container and open valve to discharge all of the sample into the sample container.

v) If additional samples (or quantities) are required, repeat above procedure.

vi) If practical, clean sampler after use with appropriate solvents, brushes and rags. (See page 15 for cleaning instruction).

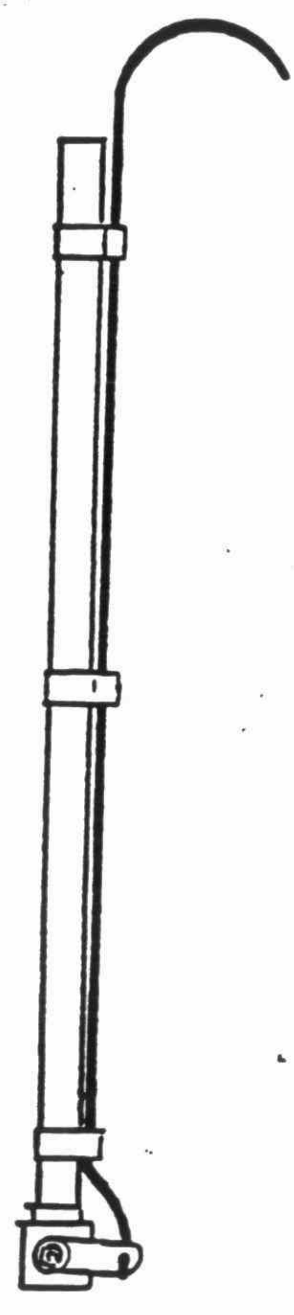

Figure 7 - Tube and Ball Valve Sampler

2. Pacs Coliwasa Sampler

The PACS COLIWASA sampler shown in Figure 8, closely resembles the EPA COLIWASA (Environmental Protection Agency's Composite Liquid Waste Sampler). It is constructed from chemicaly-resistant PVC or glass and teflon and has a positive opening/closing mechanism that is operated by a wing nut system. This sampler, which is commercially available in drum sampler and tank sampler sizes, is suitable for sampling most containerized liquid wastes.

Procedure for Use

i) Open valve mechanism by means of the wing nut system and visually inspect to see valve is open.

ii) Lower sampler vertically in a similar slow consistent rate that was described for the tube and ball sampler.

iii) When sampler touches the bottom of the sample container, wait 3 seconds and close valve by turning wing nut.

iv) Raise sampler vertically and remove it from the liquid being sampled. Clean outside with a suitable rag and then position sampler above sample container and open valve to discharge all of the sample into the sample container.

v) Repeat above procedure if additional samples are required.

vi) Clean sampler as soon as possible. (See page 15).

3. Concentric Tube Sampler

The concentric tube sampler shown in Figure 9, is constructed from two aluminum tubes. The inner tube is approximately 2.5 cm in diameter and has a series of longitudinal slots. The outer tube which is between 3.2 cm to 3.8 cm fits over the inner and is designed to trap a core sample. This sampling device is being used by a waste oil refining company and appears suitable for sampling waste oils. It is not commercially available.

Procedure for Use

i) Insert slotted inner tube vertically into the liquid being sampled until tube touches the bottom of the sample container.

ii) Slide outer tube over the inner and then screw the outer tube to the flange attachment located at the bottom of the inner tube.

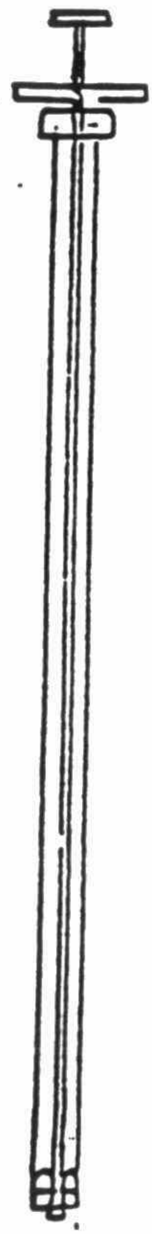

Figure 8 - Pacs Coliwasa

Figure 9 - Concentric-Tube Sampler

iii) When outer and inner tube are securely attached raise sampler vertically.

iv) Wipe outside portion of the sampler with a clean rag and then deposit sample into a suitable sample container by loosening the outer tube away from the inner.

4. Regular and Constricted Glass Tubes

Figure 10 illustrates glass tubes which may be used to sample liquid wastes. Typically, the inside diameter of these sampling tubes ranges from about 6.2 mm to 12.5 mm. The larger diameter tubes can be constricted to about 6 mm by melting with a bunsen burner or similar heating device. The constricted glass tubes tend to leak to a lesser extent than the regular glass tube. Generally, these samplers are suitable for providing core samples of low to moderate viscosity, homogeneous liquids. In addition they can be used to provide core samples of low to moderate viscosity hetergeneous liquid wastes when a high degree of accuracy is not required.

Procedure for Use

i) Vertically lower the sampler into the liquid being sampled at a slow and consistent rate. For liquids with viscosities similar to water, lower at a rate of about 30 cm per 3 to 5 seconds. For liquids with higher viscosities, lower the sampler at proportionately slower rates.

ii) When sampler touches the bottom of the sample container raise it very slightly (no more than $^1/_2$ cm), wait 3 seconds, place your thumb securely over the top end of the tube and then raise sampler vertically.

iii) Promptly place sampler over the opened sample container and remove thumb to allow sample to discharge from the tubes.

iv) If additional samples (or quantity of sample) are required repeat above procedure.

v) Discard sampler (e.g. break and leave in waste drum).

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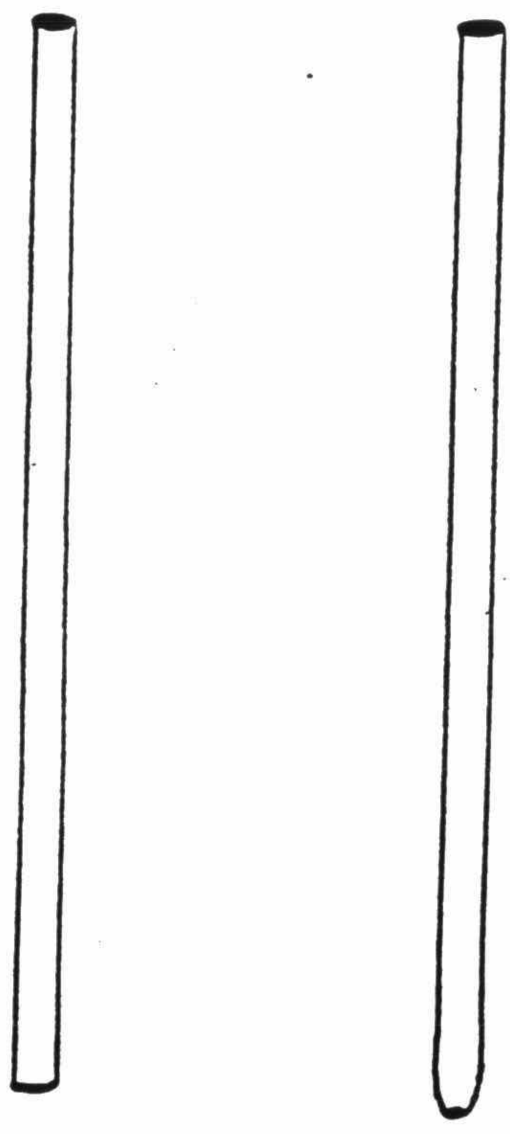

Figure 10 - Glass Tubes

APPENDIX II

SPECIFIC SAMPLING TECHNIQUES

In this section, sampling techniques are presented for various sampling situations: sampling from pipes and other process discharges, drums, landfills, lagoons, and waste piles.

The variety of physical forms of waste and the uniqueness of each sampling situation necessitates a flexible approach to acquiring samples. The procedures discussed are believed to represent the best approaches to sampling different forms of waste. However, the technique selected should be devised in each case by a person familiar with the process and with the general principles of sampling.

Pipes and Other Process Discharges

Representative samples from pipes and other process discharges are best obtained through time composite sampling. Composite sampling may be performed through the use of automatic compositors, or it may be done manually. This discussion assumes that manual sampling is performed. If it is determined that the flow of the pipe is variable, flow proportional sampling may be required. This sampling includes mechanical sampling and one should enquire with the laboratory or a consultant before attempting it.

There are two general types of process discharges:

i) liquid or slurry discharges: pipes, valves or sluiceways;

ii) solid or semi-solid discharges: conveyor belts or filter presses.

 i) For slurry and liquid discharges, a dipper-type sampler should be used. The dipper can be easily constructed out of material on hand at the plant. The dipper bucket should be of an appropriate non-reactive material similiar to the sample containers. The size of the bucket used should increase with increasing waste stream size and it should be cleaned after each sample is collected.

    Each time a grab sample is taken, the dipper is first rinsed in the sampling stream. Then the dipper is passed in one sweeping motion through the discharge stream so that the dipper is filled in one pass. One should not sample from the edge of the stream only.

If the cross-sectional area of the stream is large in comparison with the size of the dipper, more than one pass may be necessary to sweep the entire cross-sectional area. Each grab sample should be emptied into the composite container and the entire contents mixed well.

ii) Solid or semi-solid discharges on a belt should be sampled with a scoop or a shovel. The shovel should be chosen or fabricated to match the width and general contour of the belt as closely as possible. The grab samples can be taken at any convenient point along the belt, as long as the entire width of the belt is sampled. Any fines or liquid present on the belt at the sampling point should be included in the sample.

Another common type of solid discharge is filter cake. If samples are taken as the material is produced, then a trowel or shovel may be useful, depending on the type of filter. Care should be taken that the sample represents the entire waste stream.

In each case the sampling frequency and the number of grab samples combined to composite samples depend on the time variability of the waste and the time representation of the sample. In the sampling of point discharges, samples can be taken every hour for 8 to 24 hours, (depending on the process schedule) and combined to form a daily composites. As an alternative, samples can be taken daily for a week, and the daily samples combined into a weekly composite. Again, the sampling period and number of samples will vary for each process. Therefore, it is important that the sampling personnel be familiar with the spatial and temporal variability of the waste stream.

Often solid discharges, (e.g. filter cakes) fall from the press or plate-and-frame filter into a hopper or storage area. In this case, a more long-term composite may be obtained by sampling the material after it has accumulated for a period of time. For example, filter cake can be allowed to accumulate in a hopper for 24 hours, and then random core samples can be taken using as a simple two-dimensional random sampling strategy. (If separation of the waste appears to have occurred in the storage container, the waste should be well mixed before drawing the samples.) The samples should be combined to form a 24-hour composite. The process should be repeated enough times to obtain the number of samples required for analysis. Sampling filter cake from a hopper would require the use of a grain sampler or a trier, depending on the water content of the material. In each case, the composite should be mixed until it is

homogeneous before sub-samples are split for analysis.

Drums

For waste contained in drums, each drum should ideally be sampled. If not practical due to the large number of drums, a representative number of drums must be determined and the drums sampled randomly.

For each selected drum, a single sample representing the entire depth of the drum along the centre is required. Equipment used for sampling waste in drums includes weighted bottles (for heterogeneous wastes) COLIWASAs, grain sampler, and triers. COLIWASAs and weighted bottles are best suited to sampling liquids and slurries; if the sample if made of dry granules or powder, a grain sampler should be used. A trier should be used to sample moist or sticky solids.

Landfills - Lagoons - Waste Piles

The sampling program for wastes contained in landfills, lagoons or large waste piles must be designed to ensure that information can be collected with a maximum reliability and minimum cost. Four basic sampling approaches are presented below. Detailed information can be obtained from the McCoy Study (Statistical Methodology for Site Sampling, prepared by E.P. McCoy Associates) for the Waste Management Branch, (MOE, 1986).

(1) **Simple Random Sampling**

In a simple random sampling, the chances of selection of any particular segment of the waste site must have an equal probability for selection to any other segments. Simple random sampling may not give the desired precision because of the large statistical variations in the results. However, where there is a lack of information about the area of the site or about the constituent distribution, the simple random sampling or systematic sampling (see (3)) designs are the best.

(2) **Selective Sampling**

If one has already obtained extensive knowledge of a waste stream, it may be possible to reduce the number of samples required. For example, if a waste is known to stratify, it is possible to sample the stratum of greatest concern.

At least two samples must be taken from each stratum in order to obtain an estimate of the sampling error. The number of sampling units is allocated according to the relative size of the stratum and the total site.

(3) Systematic Sampling

In a systematic sampling design samples are collected in a regular pattern (a grid or a line transect) over the site. The starting point is located by a random process and all the other samples are collected at regular intervals in one or more directions. Two possible problems may limit the use of this design: difficulty in estimating the sampling error and the presence of trends and periodicity in the data. In the first situation, double sampling is done at a number of sites. In the second case, special statistical methods must be used to assess the analysis of data from sequential sampling.

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(4) Judgemental Sampling

Where information on the waste is not available and resources are limited, samples can be taken using professional judgement. This judgemental sampling technique usually reflects the scientist's own bias and should not be used where there is a potential for litigation. Duplicate or triplicate samples should be taken to measure the sampling precision.